BLH

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INSTRUMENT CENTER

BALDWIN-LIMA-HAMILTON CORPORATION
ELECTRONICS DIVISION • WALTHAM 54, MASSACHUSETTS

BLH
STRAIN INDICATOR
TYPE 20

INSTRUMENT
CENTER

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INSTRUCTION MANUAL

FOR BLH
STRAIN INDICATOR
(TYPE 20)

Designed and Manufactured by
BALDWIN-LIMA-HAMILTON CORPORATION
ELECTRONICS AND INSTRUMENTATION DIVISION
WALTHAM, MASSACHUSETTS

TABLE OF CONTENTS

General Information ..... Section 1

Description ..... Section 2

Installation ..... Section 3

Operation ..... Section 4

Calibration ..... Section 5

Maintenance ..... Section 6

Trouble Shooting ..... Section 7

Specifications ..... Section 8

Replacement Parts List ..... Section 9

Product Data Sheets ..... Appendix

SECTION 1
GENERAL INFORMATION

The BLH Portable Type 20 Strain Indicator is used for field and laboratory measurements of strain in structures and machines by indicating the change of electrical resistance in strain gages.

This instrument, Figure 1, has been designed and calibrated especially to work with resistance strain gages having an initial resistance of 120 ohms and a gage factor of any value from 1.5 to 4.5. Gages with initial resistance of 60 to 2000 ohms can be used with equal ease and accuracy.

The Indicator can be used with a self contained battery power pack for short tests and field work where AC power is not available or AC power in the laboratory for prolonged tests.

The Type 20 Indicator uses a manually operated null-balance system with digital readout for fast accurate reading. The indicator has a total range of 0—±30,000 microinches per inch, covered by 12 intervals of 5000 microinches per inch each.

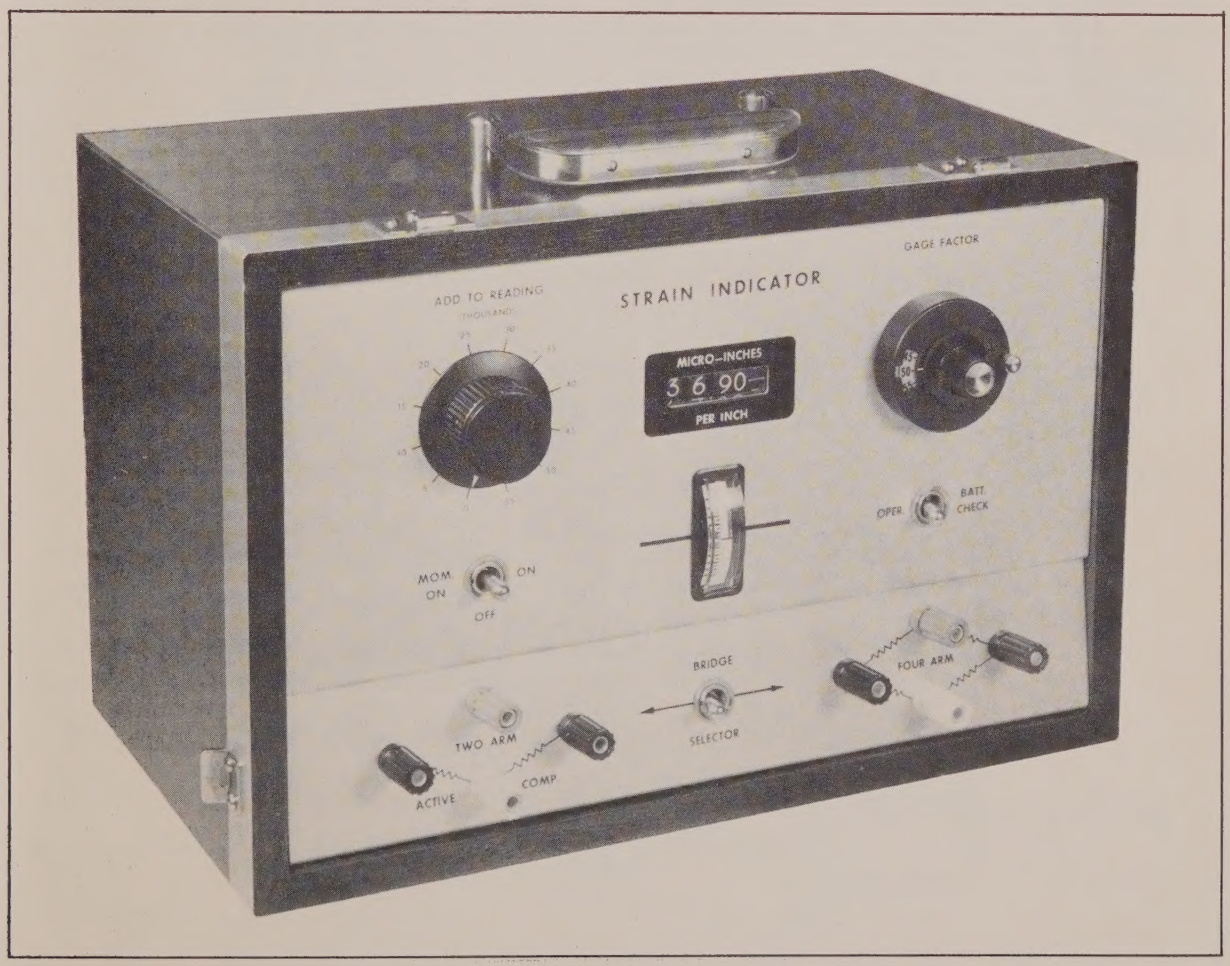


Figure 1. BLH Type 20 Strain Indicator

SECTION 2
DESCRIPTION

2.0 DESCRIPTION

2.1 The Type 20 Strain Indicator measures the change in electrical resistance of strain gages and thru a manually null-balance digital readout system transforms this change into a reading in microinches per inch strain.

2.2 Circuitry of the Indicator includes a 1000 cps transistorized oscillator, a transistorized amplifier, a meter, and a measuring circuit. The oscillator circuit includes a transformer supplying 1000 cps power to the strain gage configuration and to the measuring circuit. Figure 2 illustrates by block diagram the principal of the manual null-balance circuit. The difference (Ee) between the strain gage bridge output (E_s) and the measuring circuit voltage (E_m) is fed to the amplifier. The amplifier output passes thru a phase-sensitive detector producing a DC voltage measured by the meter; the polarity and magnitude of this voltage is dependent upon the polarity and the magnitude of the difference between (E_s) and (E_m).

2.3 The magnitude of the measuring circuit voltage (E_m) is determined by the position of the slidewire potentiometer for a selected setting of the ADD TO READING switch.

The null METER reading is reduced to zero by manually adjusting the BALANCE CONTROL, thereby generating a measuring circuit voltage exactly equal and 180° out of phase with the strain gage voltage. A digital counter, geared to the slidewire potentiometer, indicates the magnitude of the measuring circuit voltage. The counter has a scale of 0-5000 microinches per inch.

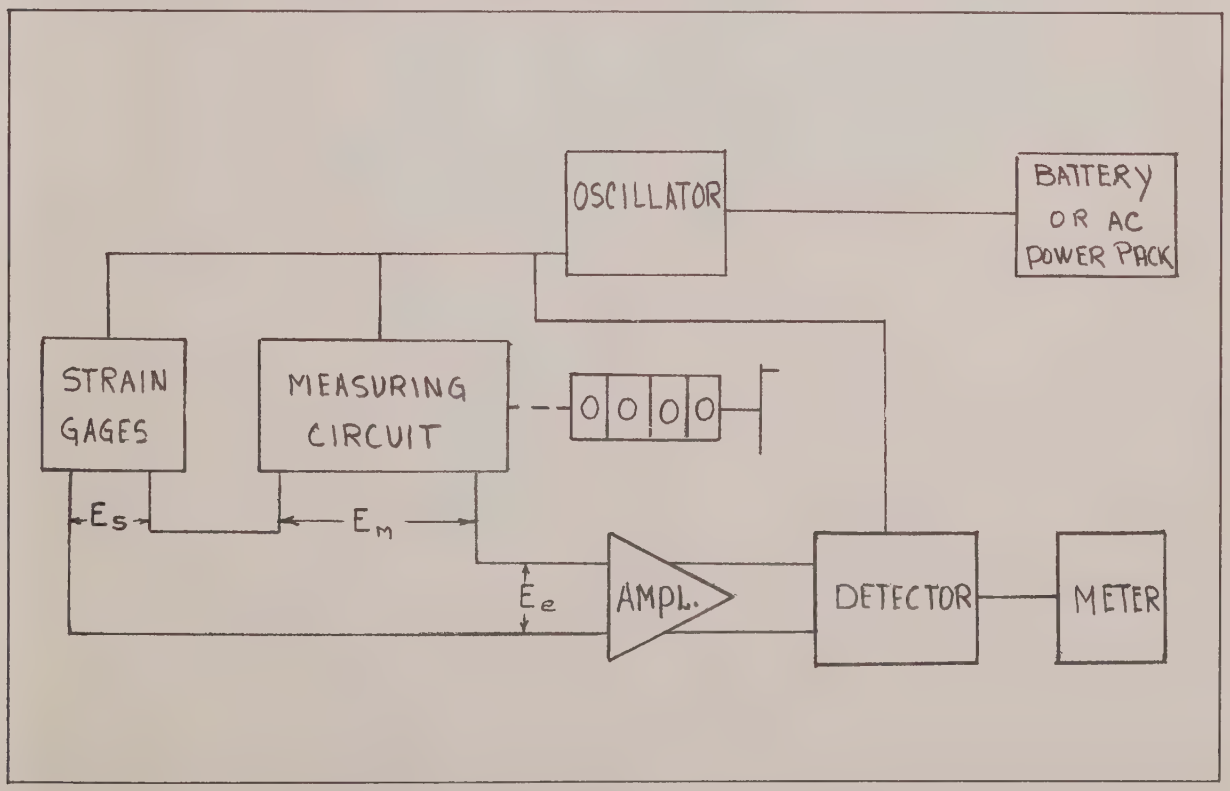


Figure 2. Manual Null Balance, Block Diagram

2.4 The ADD TO READING switch is graduated from 0 to 55 and shifts the reference point of the counter by 5000 microinches per inch for each step of the switch. The position of the ADD TO READING switch corresponding to 30,000 microinches per inch (30, switch marking) is the zero of the Indicator. This allows for ±30,000 microinches per inch of operation.

2.5 The gage factor potentiometer is graduated from 1.5 to 4.5 and when set to the factor corresponding to that on the gage in use applies the proper voltage to the measuring circuit for that gage.

2.6 Two sets of color coded terminal connections are mounted on the lower left and right side of the front panel. The left hand group is marked for two arm bridges and the right hand group for a four arm bridge configuration. The BRIDGE SELECTOR toggle switch located between the terminal groups selects the bridge configuration to use by positioning the switch in the direction of the terminal group used. The two arm bridge contains an internal half bridge of 500 ohms to complete the bridge for that grouping.

2.7 Should the operator desire to take but a single occasional reading the power switch has a MOMENTARY ON position. The switch must be held in this position while taking the reading and will return to off when released. This will save the life of the batteries. The BATTERY CHECK-OPERATE switch is used to check the battery voltage. When held in the BATTERY CHECK position the METER needle should deflect upward and past the red area. If the meter needle remains in the red area the battery is weak and should be replaced. For normal operation the switch is maintained in the OPERATE position.

2.8 The CAPACITIVE BALANCE group, located on the right side of the instrument, consists of a selector switch and a potentiometer. When the CAP. BAL. selector switch is on the CAP. ADJ. position the instrument meter is used to indicate a null when adjusting the CAPACITY BALANCE potentiometer. The CAP. BAL. selector switch can then be positioned on OPER. NORMAL Position, with CAPACITY balance out of the circuit, or the OPER. CAP. position with the CAPACITY BALANCE in the circuit. See Section 4, operation, for detailed operating procedure.

2.9 A battery saver switch, that shuts off the power when the side door is closed, eliminates battery discharge when the indicator is not in use.

2.10 The scope jack on the right side panel is used for connecting to any standard oscilloscope for observation of dynamic strains.

SECTION 3
INSTALLATION

3.0 INSTALLATION

3.1 If the Strain Indicator is packed for shipment, remove the Indicator from the container. Examine all packing material to prevent loss of any items.

3.1.1 A six foot power cable is included with the Indicator when the AC Power Pack is used. One end of the cable is connected to the 115 V AC connector (J1), located on the lower right of the right hand side of the instrument, see Figure 3, the other end of the cable is connected to a source of 115 V AC 60 cps power.

3.2 WIRING. It is advisable to select lead materials which have low, stable resistivity, minimum temperature coefficient of resistance, coated with insulating materials which are equivalent to the electrical insulating quality of the gage carrier and bounding cements employed. The following materials have been found suitable for BLH strain gage use. For other than BLH strain gages consult the manufacturer.

Conductors	Operating Temperatures °F	
	Stable	Maximum
Nickel-clad copper	700	1000
Stainless steel-clad copper	800	1300
Nickel-clad silver	1000	1500
Nichrome	700	1700

Insulation	Temperature Range
Nylon	Below −100°F
Vinyl	−100 to 150°F
Polyethylene	−100 to 200°F
Teflon	−100 to 500°F
Glass impregnated silicone	above 500°F
Glass sleeving	above 500°F

It is preferable to solder connections to the gage lead wires. Clean, tinned spade type lugs soldered to the lead wires are preferable for connections to the binding posts of the instrument. Stranded wire, if used, should have all strands intact and special care should be taken to see that all strands are soldered.

3.2.1 When the lead wire lengths are more than 50 feet, special circuits or shielding may be necessary. See Section 4 on Phase Balancing.

3.2.2 In locations where the strain Indicator is being operated in the vicinity of strong electrical disturbances, it may be necessary to use shielded cable for the leads to the active and compensating gages when these lead lengths are long. The shield of this cable should be grounded at only one point.

3.3 CONNECTION TO INSTRUMENT. Two arm bridge configurations are connected to the left hand group of color coded terminals as shown by the engraving on that group of terminals. The four arm gage configuration (full bridge) are connected to the right hand group of color coded terminals. The BRIDGE SELECTOR switch is then positioned toward the group of terminals in use.

SECTION 4
OPERATION

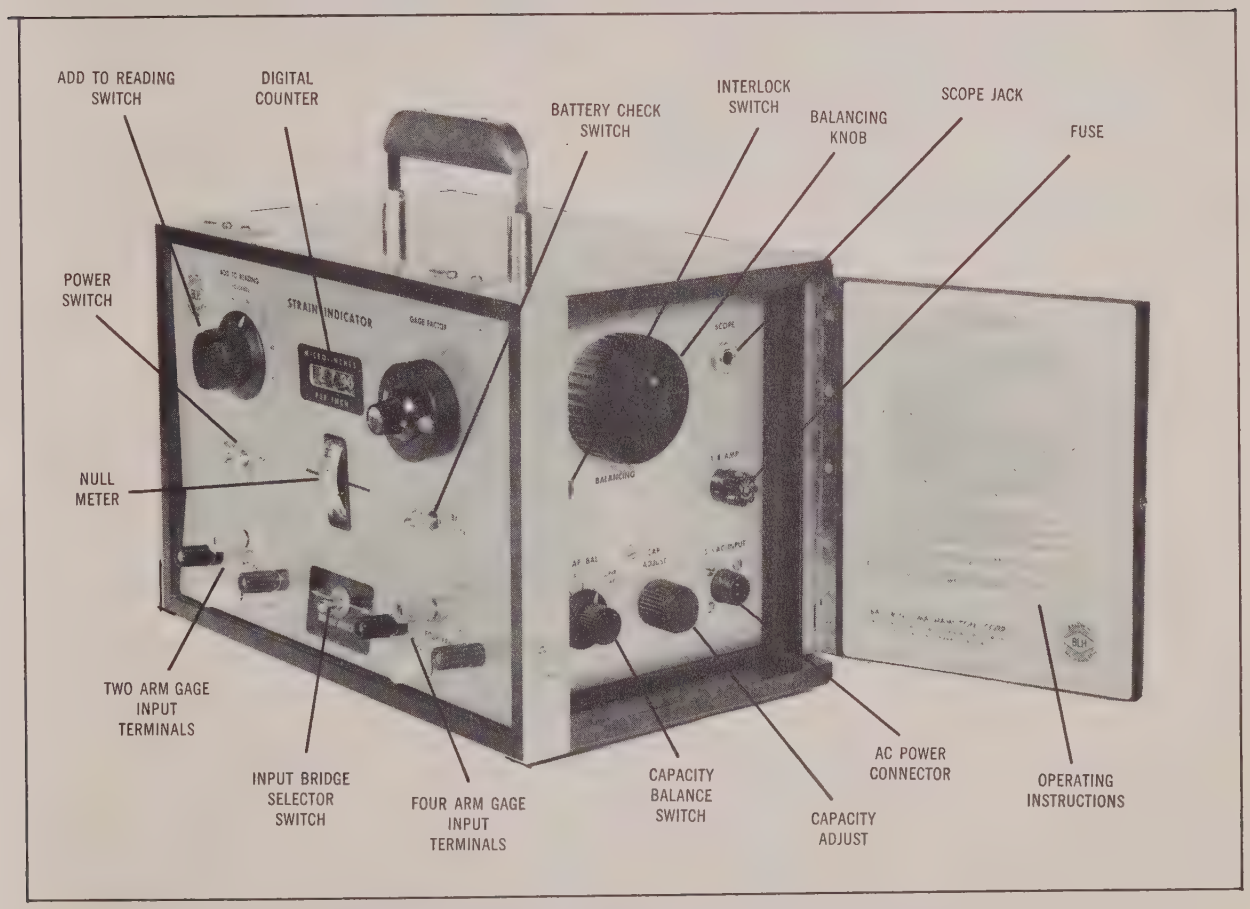


Figure 3. Strain Indicator, Operating Controls

4.0 OPERATION

4.1 PRELIMINARY ADJUSTMENTS. In the following instructions, refer to figure 3, which illustrates the indicator operating controls. To operate the indicator, remove the top cover, open the right side door and perform the following steps:

a.1. BATTERY OPERATION: Check the batteries before each use by positioning the OPER. BATTERY CHECK toggle switch to BATTERY CHECK. If the meter moves upward and beyond the red area, the batteries are satisfactory. If not, replace with new ones as instructed in section on maintenance. Repeat check hourly if the indicator is used continuously. To conserve batteries, always turn power off when not taking readings.

a.2. AC OPERATION: Check power supply voltage once a day by positioning the OPER. BATTERY CHECK switch on BATTERY CHECK. If the meter shows beyond the red area the voltage is satisfactory. If not see section on Maintenance.

b. Turn power on by positioning POWER switch to ON.

c. Position CAP. BAL. switch on the OPER. — NORM. position. If meter action appears sluggish when rotating the BALANCE knob, (55 ±15 micro-inches per inch should produce full meter deflection) bring meter to a null using the BALANCING knob. Position CAP. — BAL. switch to the ADJUST position and using the indicator meter as a null meter adjust the CAP. ADJUST until the meter dips to a null. Then position the CAP. BAL. switch to the OPER. — CAP. position. The system is now balanced for effects of capacity in the gage wiring.

d. Set the GAGE FACTOR dial in upper right corner to exactly the value listed on the container in which the strain gages are received, or the value marked on the gage itself, and make a record of this setting. In order to be able to reproduce strain readings at some later date, it is essential that the gage factor dial be set precisely at the same value as before.

e. It may be desirable at times to determine the true indicator zero in order to eliminate errors arising from slow changes of instrument zero which may be due to temperature, battery voltage drop, etc. To do this, it is necessary to take readings on two resistors or gages preferable within about 1/10% of each other, first in one position and then with the two resistors or gages reversed. The average of the two dial readings gives what is called the "indicator zero," which is used to correct all strain readings to the same basis. By this method precision measurements can be made during long-time tests. Also, measurements can be taken on the same gages with different indicators without loss of accuracy provided the external circuit is phased in accordance with Paragraph 4.1.c.

f. To make measurements on materials such as plastics and metals in the plastic region, or to increase the range of the dial so that strain readings can be made without resorting to a change of the "ADD TO READING" switch, it is only necessary to introduce fixed wire-wound resistors in the gage circuits as shown in Fig. 4, By the use of formulas shown in Fig. 4, the dial range can be increased appreciably. The resistors should all be precision, non-inductive wire-wound type accurate within ±0.25%. The Formulas hold closely for values of M up to M=10.

4.2 STRAIN MEASUREMENT. The strain in the specimen is the difference between the initial and the final instrument readings made up of the dial readings as well as the ADD TO READING switch readings.

A. Initial reading is obtained as follows (before applying strain):

1. Place ADD TO READING switch on 30.
2. ROTATE BALANCING knob in direction to bring meter pointer to zero. If meter pointer cannot be brought to zero, leave COUNTER AT END TO WHICH IT HAS BEEN TURNED (0 or 5000).
3. Rotate ADD TO READING switch until meter pointer kicks across scale.
4. Rotate BALANCING knob to bring meter pointer to zero.
5. Record COUNTER and ADD TO SWITCH readings.

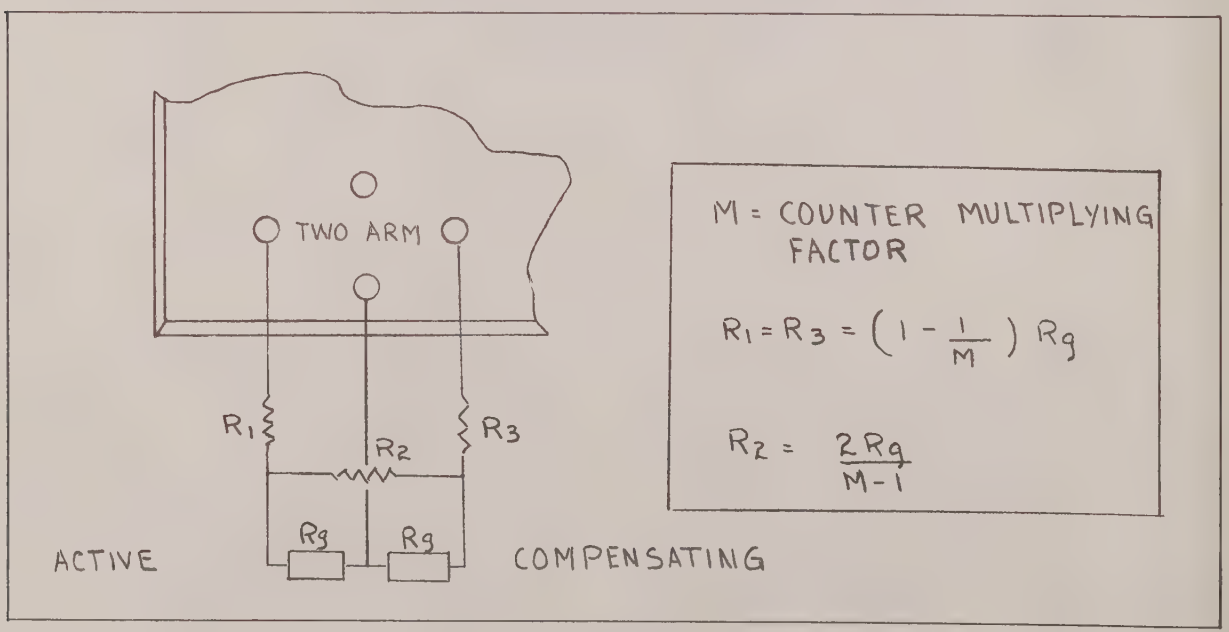


Figure 4

B. Final READING (after applying strain)

1. Proceed as in A 2 to 4 above.
2. Record all COUNTER and ADD to READING switch readings with meter pointer at zero and strain applied.

C. Computation of strain.

Instrument readings as indicated in A-5 and B-2 in preceding paragraph give both the magnitude of the strain and information as to whether the specimen is under tension or compression.

$(T_2—T_1)\ 1000 + D_2—D_1$

T_2 — Final ADD TO READING switch position.

T_1 — Initial ADD TO READING switch position.

D_2 — Final Counter reading.

D_1 — Initial Counter reading.

The sign of the strain given by the formula will indicate whether the strain is tension or compression. Positive sign corresponds to tension in measuring gage.

4.3 MEASUREMENTS WITH STRAIN GAGES OF RESISTANCE OTHER THAN 120 OHMS. This instrument can be used in connection with any resistance wire strain gage having an initial resistance between 60 and 2000 ohms. The active and compensating gages preferable should have their initial resistances equal within 1/2%. The wiring and installation of these gages and the operation of the instrument is the same as for standard 120 ohm gages.

It can be seen from Figure 5, that a gage factor multiplier is not necessary and the gage factor shown on the gage can be set directly for gages with initial resistances of 60 to 2000 ohms.

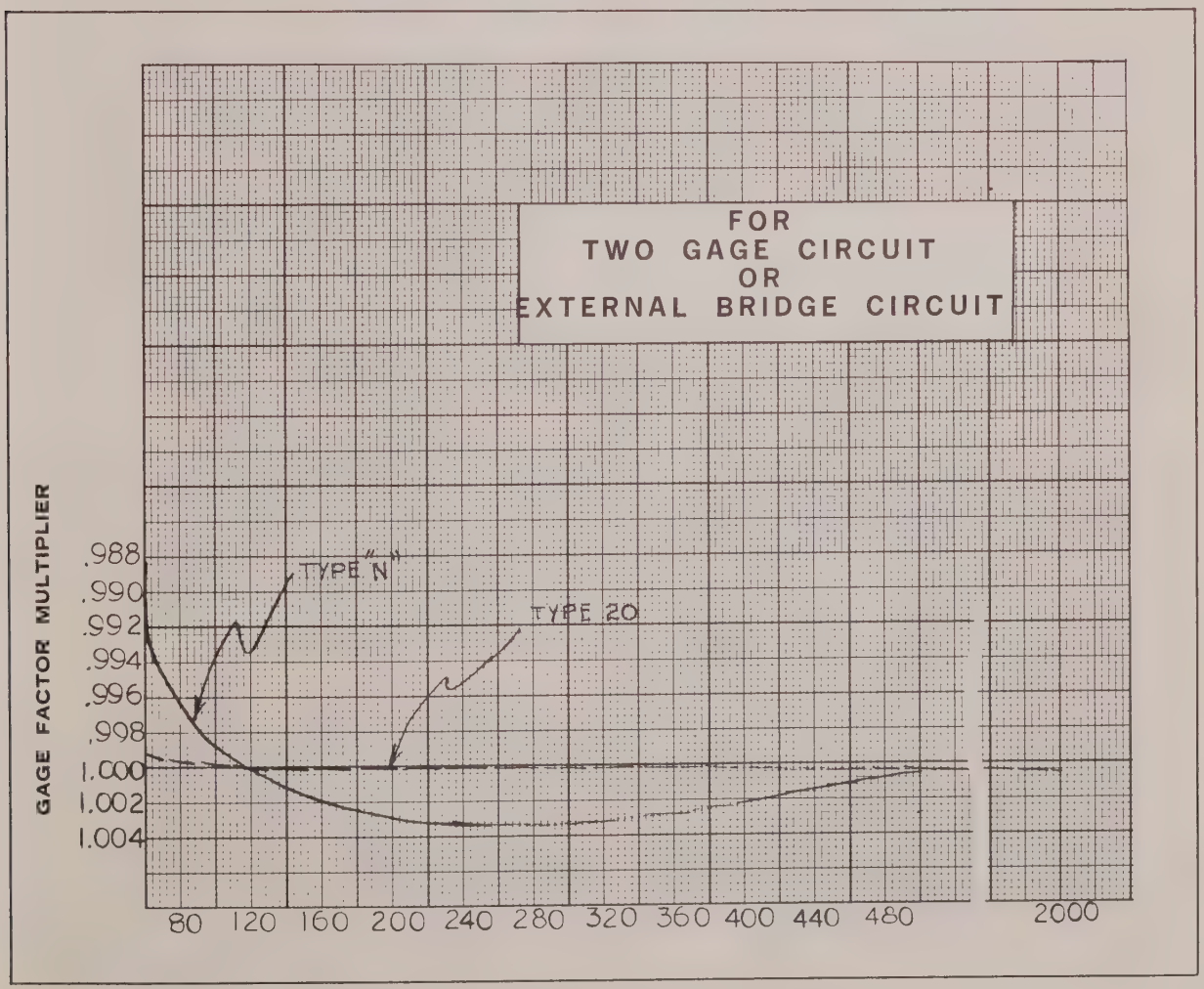


Figure 5. Gage Resistance in OHMS

4.4 EFFECT OF LEAD WIRE RESISTANCE. While for most measurements the effect of lead wire resistance is negligible, it may be of importance where long leads or small-size leads are involved and high accuracy is required.

The presence of lead wire resistance in series with a strain gage reduces the effective gage factor in proportion to the ratio of the lead resistance to the gage resistance. This may be taken into account either by applying corrections to the indicated strains or by reducing the gage factor setting.

For example, suppose there is an active 120 ohm strain gage 50 ft. from the instrument, the lead wires being #18 gage copper (6 ohms per 1000 ft.), while the compensating gage is at, or close to, the instrument. The total lead wire resistance (1000 ft.) of 0.6 ohm causes a reduction in the effective gage factor of 0.6/120, or 0.5%. Therefore, if the gage factor dial is set at the true gage factor (as found on the gage package) the indicated strains will be 0.5% low. If the gage factor dial is set as 99.5% of the true gage factor, the instrument will automatically compensate for the lead wire resistance effect. If the lead wire resistance exceeds about 5% of the gage resistance, a more exact calculation is required. However, if the active and compensating gages are at the same location, the effective gage factor reduction will be one-half of that computed above, and may be compensated for in the same manner.

4.5 PHASE-BALANCING WHEN USING A SWITCHING AND BALANCING UNIT WITH THE STRAIN INDICATOR. In most applications it is unnecessary to take any precautions relative to capacitive balance of the external gage circuit. However, the existence of appreciable capacitive unbalance in the wires leading to the active and compensating gages can cause a marked decrease in meter sensitivity. If these wires are run in the same cable, the effect will be negligible for 120 ohm gages for cable lengths up to 100 feet. On the other hand, if the compensating gage is at the instrument and the active gage is 50 feet away, the effect can be serious. In order to eliminate this effect, it is necessary to add capacitance across the gage which has the smaller shunt capacitance: in this example capacitance would be added across the compensating gage. In general, what the size of this capacitance should be, and whether it should be shunted across the active or compensating gage terminals, has to be determined experimentally. Two different methods may be used. In both methods a decade capacitor, or its equivalent, having a range of 0 to 5000 micro-microfarads in steps of 100 micro-microfarads will be found convenient. This range of capacitance is sufficient for most cables for lengths up to 100 feet. In the following methods, the use of gages of approximately 120 ohms resistance is assumed. The CAP. BAL, switch of the indicator should be on the OPER. NORM. position.

Method 1.
Place the decade capacitor across the compensating gage terminals of the first channel of the Switching & Balancing Unit. With the decade at zero capacitance, balance the Strain Indicator meter. Now observe the deflection of the meter when the slidewire counter is rotated through two small divisions. Set the decade capacitor at 300 micro-microfarads, rebalance the meter, and observe the meter sensitivity when the dial is rotated two small divisions. Continue to add more capacitance, and repeat the procedure, until the capacitance value necessary for maximum meter sensitivity has been determined. If no such maximum is observed, transfer the decade capacitor to the active gage terminals and proceed as before. Repeat for each channel of the switching and balancing unit.

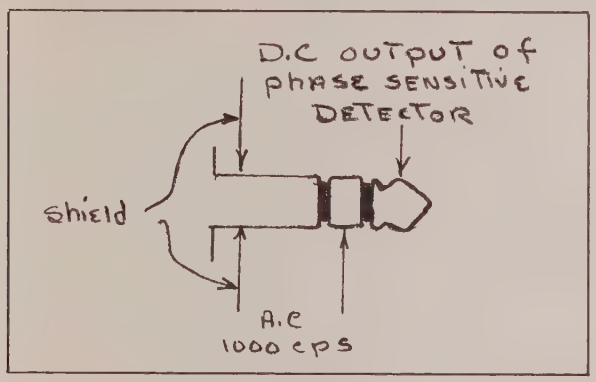
Method 2.
Balance the Strain Indicator meter. Connect either an oscilloscope of an AC vacuum tube voltmeter to the scope jack. The sleeve side of the plug should be connected to the low or ground connection of the scope (see paragraph 4.6 for Jack connections). Connect the decade capacitor across the compensating gage terminals. Since plugging into the scope jack disconnects the meter circuit, rebalancing is now accomplished using the scope or VTVM as a null indicator. With switching & balancing unit channel selector switch on channel one, rebalance the scope to null and observe the amplitude. Now set the decade capacitor at 100 micro-microfarads, rebalance to null and observe the amplitude. If the amplitude has decreased, add more capacitance and rebalance as necessary to obtain the best null. If, on the other hand, adding capacitance across the compensating gage increases the voltage, transfer the decade capacitor to the active gage terminals and repeat the procedure. Repeat for each channel in use on the switching and balancing unit.

In general, Method 1, is simpler than Method 2, but the latter should be used in the event that the Strain Indicator meter sensitivity is very low and the results of Method 1 are inconclusive. When using gages of resistance higher than 120 ohms, the procedure is exactly the same as that just described with the exception that in Method 1, the first setting of the decade capacitor, instead of being 300 micro-microfarads, should be reduced approximately in inverse proportion to the gage resistance.

4.6 VISUAL INDICATION OF DYNAMIC STRAIN. Although the Type 20 Indicator is designed as a null-balancing instrument for the measurement of static strains, the provision of a "Scope Jack" in its side panel permits the convenient and practical observation of dynamic strains with the aid of any standard cathode-ray oscilloscope. If the magnitude of the strain to be observed is below about 5000 micro-inches per inch, for a gage factor of 2.0, the indication is quantitative. Beyond that, the strain indicator amplifier becomes non-linear, but by using the circuit of Figure 4, proportionately larger dynamic strains can be observed with good linearity. The procedure is as follows:

1. Set the gain of the oscilloscope so that a signal of approximately .05 volt will occupy most of the screen. This is about the magnitude of the signal resulting from a 1000 microinch per inch unbalance.

2. Make the proper connections between the oscilloscope and the Scope Jack Plug. A three conductor plug, switch craft #90 or its equivalent, should be connected as follows:



3. In general, the signal on the oscilloscope will be appreciable; reduce it to a minimum by moving the balancing knob. The remaining signal is due in part to capacitive unbalance on the external gages, which should now be capacitively balanced as follows: With the CAP. BAL. switch on CAP. OPER. position adjust the CAP. ADJ. potentiometer until the signal on the oscilloscope is at a minimum. Then adjust the balancing dial to see if the signal can be further reduced. Repeat this procedure until the only signal that remains is that consisting of the second harmonic of the oscillator frequency.

4.7 USE WITH EXTERNAL BRIDGE CIRCUIT. In certain strain gage investigations it is advantageous to connect the gages into a closed external bridge circuit which is connected to the Strain Indicator by four lead wires (usually a 4-wire shielded cable) to the right hand group of terminals. The effect of variations in cable and terminal contact resistance upon the strain measurements, are then minimized because both sources of error are external to the gage bridge.

The external bridge also lends itself to realization of increased measuring sensitivity in cases where it is practical to employ two active and two compensating gages (connected alternately around the bridge loop). The indicated strain will then be just twice the actual strain since the two active gages will produce an additive effect in unbalancing the bridge. This arrangement has been used effectively where the strains to be measured are very small. To use the Type 20 Strain Indicator with an external bridge circuit connect the bridge to the right hand group of terminals as follows:

1. Connect the power input terminals of the external bridge to the Black and Green binding posts.

2. Connect one bridge output terminal to White binding post.

3. Connect the other output terminal to Red binding post.

4. Set the gage factor dial to the value of the gages in use.

5. Read the instrument and calculate strain as in 4.2 A, B, and C.

NOTE: The Type 20 Strain Indicator can be used to measure the response of any of the Baldwin line of standard BLH pickups (such as load and pressure cells) all of which are bridge circuits adjusted to standard output and fully compensated for temperature. For this service, set the gage factor dial at exactly double the value found from Figure 5. Measure the "apparent strain" in microinches per inch in the manner outlined above and divide by the number 2000. The result is the true pickup output expressed in terms of millivolts output per volt input.

For example, given a standard 5000 lb. capacity BLH Type "C" load cell which has a terminal resistance of 120 ohms. From Figure 5, we find that the gage factor dial must be set at 2 x 1.000 or 2.000. The output of the cell is factory adjusted to 2.00 mv/v at 5000 lbs., so it is evident that capacity load will produce an apparent strain reading of 2 x 2000 microinches per inch. In other words, the true load is $\frac{S \times 5000}{2 \times 2000}$ where S is the apparent strain.

The effect of lead wire resistance in the case of an external bridge circuit may need to be considered in some instances. As to lead wire resistance inside the bridge loop, the presence of lead wire resistance in the arm of the bridge reduces the effective gage factor of the strain gage in that arm in proportion to the ratio of the lead resistance to the gage resistance. Lead wire resistance external to the bridge loop is of no consequence at all if it is in series with the output terminals of the bridge since at most it amounts to a few ohms in a high impedance circuit.

Any lead wire resistance in series with the power input terminals of the bridge will reduce the effective output of the bridge in proportion to the ratio of the lead resistance to the bridge resistance as measured across the power input terminals. Correction can be effected in the same manner as explained in the example in paragraph 4.4.

SECTION 5
CALIBRATION

5.0 CALIBRATION

5.1 The Strain Indicator measuring circuits is constructed of highly stable fixed and variable wire wound resistors and should give long service without recalibration. If a component in the measuring circuit should fail and necessitate a replacement or if for other reasons the accuracy of the Indicator is in doubt, a check of the calibration can be made by the use of the Baldwin Type 615 Calibrator (see Product Data sheet 4407 in Appendix).

5.2 To check the calibration of the Type 20 Indicator using the Type 615 Calibrator proceed as follows:

a. Connect the left hand group of the Calibrator's color coded terminals, color for color to the right hand group of color coded terminals of the Strain Indicator.

b. Position controls on Calibrator as follows:

BRIDGE SELECTOR SWITCH	— 120 ohms
RANGE SWITCH	— 0-10
STEP SWITCH	— 0

c. Position controls on Type 20 Indicator as follows:

BRIDGE SELECTOR SWITCH	— FULL BRIDGE
GAGE FACTOR	— 2.0
ADD TO READING SWITCH	— 30
POWER SWITCH	— ON

d. Prior to operation check Battery or D.C. Power of Strain Indicator by placing OPER-BATT.-CHECK switch to BATT-CHECK.

e. Place the CAP. BAL. switch in the OPERATE NORMAL position.

f. Zero the Strain Indicator as in para. 4.2 A1 to A5 and record reading.

g. Set STEP switch of the Calibrator to 1mv/v.

h. Zero the Strain Indicator as in f above and record reading.

i. Set the STEP switch of the Calibrator to 2mv/v, 3mv/v in 1mv/v steps through 10mv/v pausing at each setting to zero the Strain Indicator and record the reading.

j. A series of readings from 0 to 20,000 microinches per inch in 2000 microinches per inch steps for each 1mv/v reading should be obtained. Compute each value as in Para 4.2e.

k. Readings in the opposite direction are obtained in the same manner but first reverse the Black and Green leads at the Calibrator.

5.3 Should this check of the calibration reveal errors of more than $\pm$50 microinches per inch at $\pm$20,000 microinches it is recommended that the Strain Indicator be returned to Baldwin-Lima-Hamilton, Waltham — Mass. for recalibration.

SECTION 6
MAINTENANCE

6.0 MAINTENANCE

6.1 GENERAL. Periodic inspection or maintenance is not necessary and nothing need be done unless trouble is encountered. The transistors, capacitors, and resistors are operated well within their peak ratings and should give long, trouble-free service.

6.2 INSTALLING BATTERY POWER PACK. Remove the Indicator from the case by removing the two screws on the bottom side. Lift the unit out of the case and install the batteries as follows (see figure 6a).

a. Use two 6v Burgess F4BP batteries or their equivalent.

b. Secure batteries in place with battery support and two screws.

c. Use a black lead to connect the negative terminal of one battery (#1) to the positive terminal of the other battery (#2).

d. Connect a green lead from the negative terminal of battery #2 to terminal "G" on the barrier strip.

e. Connect a red lead from the positive terminal of battery #1 to terminal "R" on the barrier strip.

f. Replace Indicator in case; and replace the two screws on the bottom of the case.

CAUTION

g. Position BATT. check- OPER. switch on BATT. CHECK. The meter needle should move up and beyond the red area for correct polarity and proper supply voltage. The wrong polarity can damage the transistors in the amplifier.

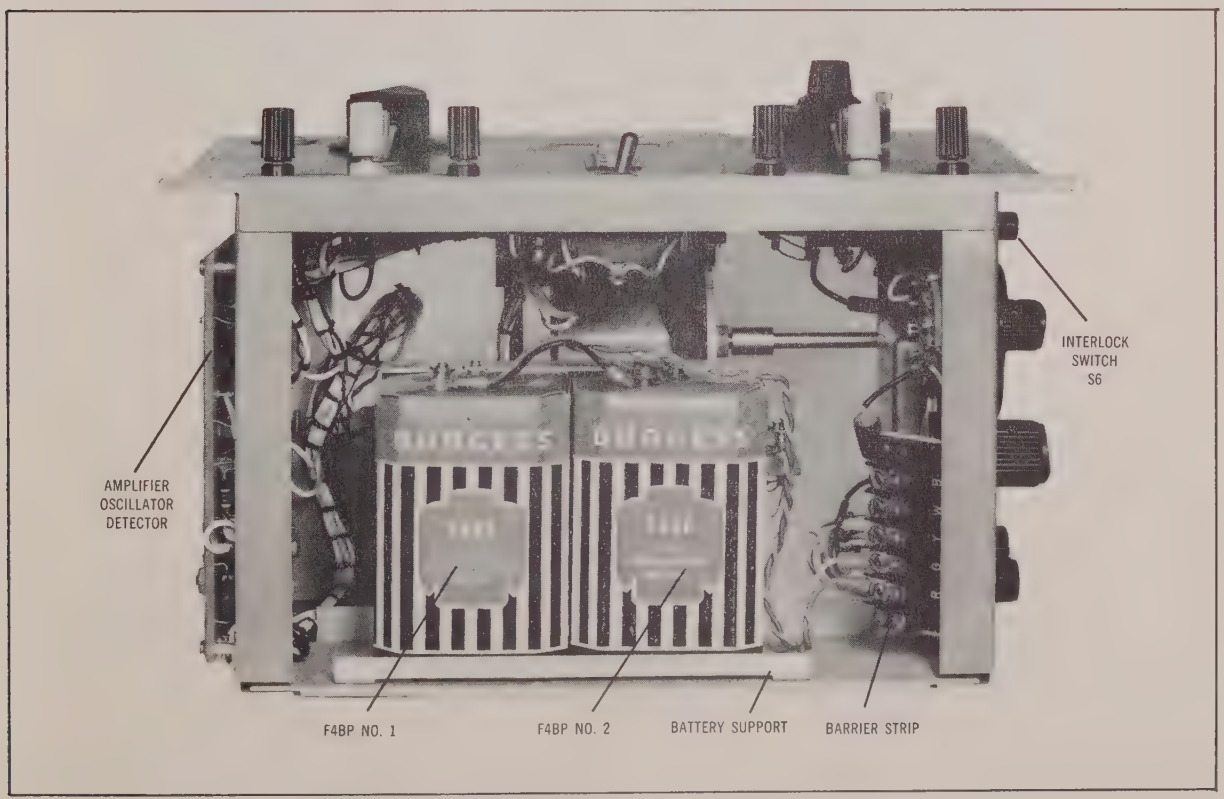


Figure 6a. Location & Mounting of Battery Power Pack

6.3 INSTALLING AC POWER PACK. Remove the Indicator from its case by removing the two screws on the bottom side. Lift the unit out of its case and install the AC power pack as follows (see figure 6b):

a. Remove screws from flanges of power pack.

b. Mount power pack in place; insert screws through the bottom of the instrument bracket into power pack mounting flanges.

c. Connect power pack cable to barrier strip as follows:

BLACK lead connects to "B" terminal (115V AC in)
WHITE lead conects to "W" terminal (115V AC in)
YELLOW lead conects to "Y" terminal (GND)
GREEN lead connects to "G" terminal (−12 volts)
RED lead connects to "R" terminal (+12 volts)

d. Replace Indicator in case and replace two screws on bottom of case.

e. CAUTION. Position Battery check switch on BATT. CHECK. The meter needle should move up and beyond the red area for correct polarity and proper supply voltage. The wrong polarity can damage the transistors in the amplifier.

f. Replace Indicator in case and replace the two screws on the bottom of the case.

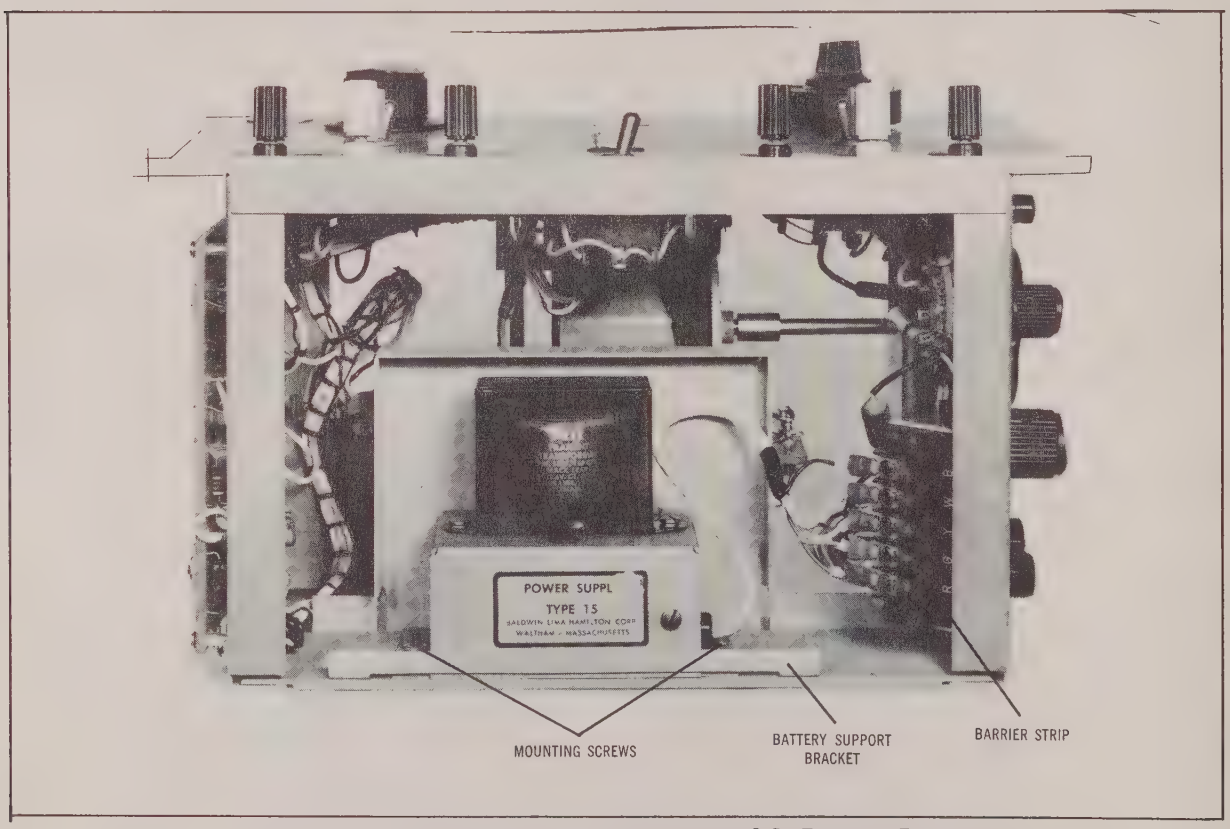


Figure 6b. Location and Mounting AC Power Pack

SECTION 7
TROUBLE SHOOTING

7.0 TROUBLE SHOOTING

7.1 GENERAL. During trouble shooting refer to figure 9, a schematic wiring diagram of the Strain Indicator. Figure 8 shows the location of the major components of the amplifier, oscillator and phase sensitive detector.

7.2.1 Check power as follows:

a. Position BATTERY CHECK-OPERATE switch on BATTERY CHECK. The meter pointer should move upwards.

b. If the pointer in step "a" is in the red area of the meter scale and the battery pack is being used, change the batteries.

c. If the pointer in step "a" is in the red area of the meter scale and the AC Power Pack is being used, use a D-C Voltmeter to check the voltage across terminals "G" (−) and "R" (+) of the barrier strip. The voltage should be 12 volts ± 1 volt.

d. If the voltage in step "C" reads zero, use an A-C Voltmeter to check the voltage across terminals "B" and "W" of the barrier strip. The voltage should be 115V AC.

e. If the voltage in step "d" reads 115V AC, the AC Power Pack is faulty and should be replaced or repaired. Refer to Figure 7, schematic wiring diagram for AC Power Pack.

If the voltage is not 115V AC, check the power source, power input cable, Power switch, and wiring to power supply.

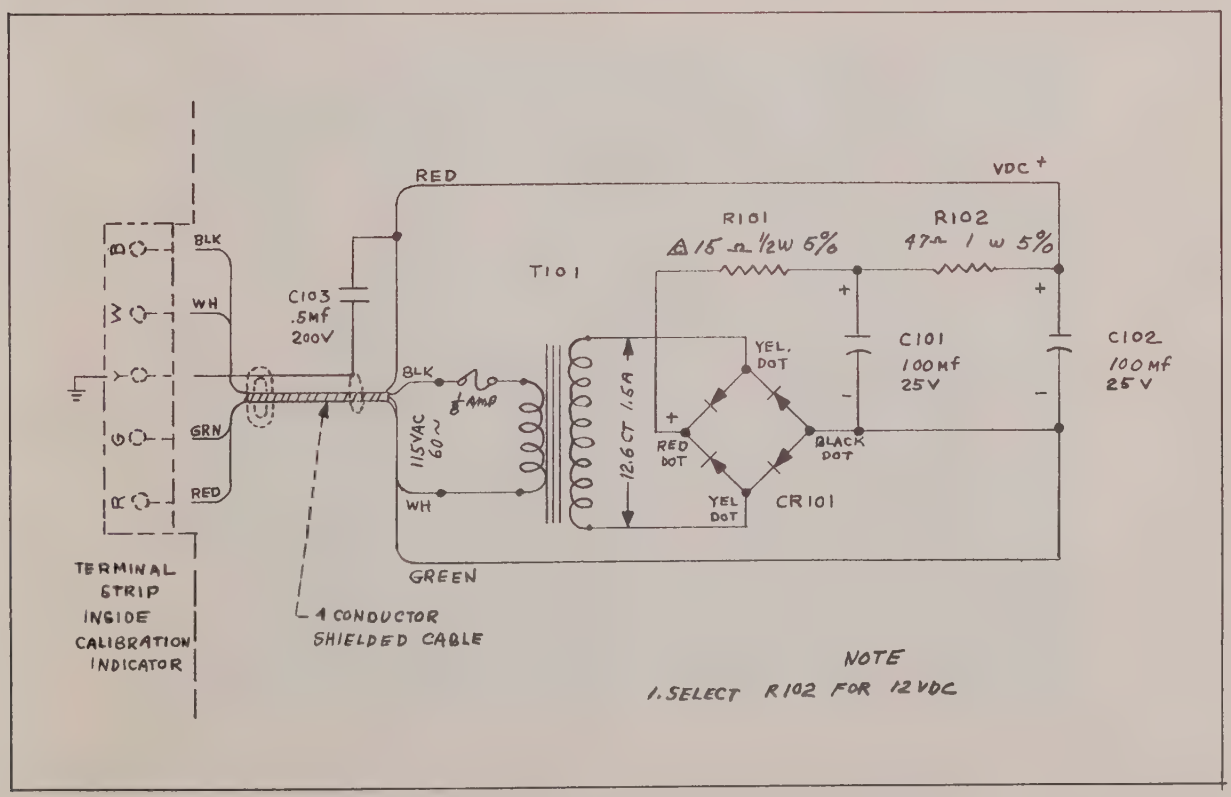


Figure 7. Schematic Diagram AC Power Pack

7.2.2 Check oscillator as follows:

a. Connect the vertical plates of an oscilloscope across the Black and Green terminals of either the 2 arm or four arm input. The oscilloscope should indicate 1000 ±50 cps.

b. If the frequency in step "a" is abnormal, use figure 9 to trouble shoot the oscillator. Repair or replace as required.

If transistors are replaced, be careful to observe polarity.

7.2.3. If the meter indication is abnormal even though the Indicator power supply, and oscillator operate properly, continue as follows:

a. Remove phase sensitive detector CR4 and replace it with a known good unit.

b. If after performing step "a", the meter indication is still abnormal, use figures 8 and 9 to check amplifier and measuring circuit. During this procedure note the following flow sequence of the Indicator.

1. The oscillator supplies 1000 cps power to the strain gage bridges and the indicator measuring circuit.

2. The difference between the strain gage unbalance voltage and the measuring circuit voltage is fed to the amplifier.

3. The amplifier output passes thru a phase sensitive detector CR4 producing a D-C voltage measured by the meter.

4. The magnitude of the measuring circuit voltage is determined by the position of a slidewire potentiometer (R19) and the ADD TO READING switch (S4).

5. The digital counter geared to the slidewire potentiometer records the magnitude of the measuring circuit voltage.

7.2.4 Amplifier — A change in the indicator reading of 55 microinches per inch ±15 microinches per inch should produce full meter deflection. Figure ~~11~~ 10 illustrates by a series of waveforms, the voltage at given points of the amplified signal. To reproduce these waveforms set the indicator controls as follows: follows:

1. Connect two 120 ohm resistors, one across the active terminals and one across the compensating gage terminals of the two arm group.

2. Place Bridge Selector switch for two arm operation.

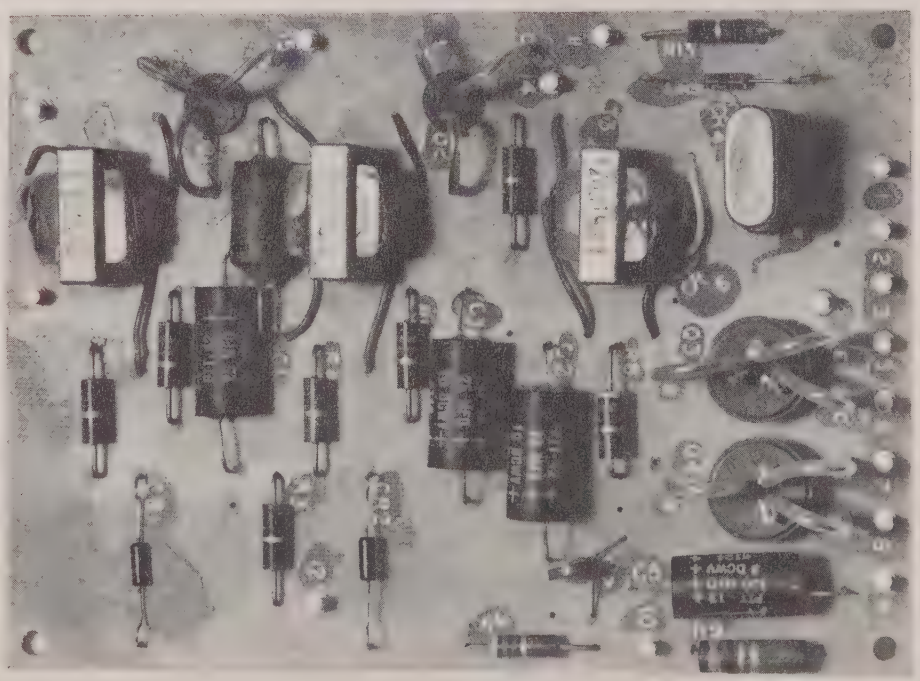


Figure 8. Amplifier Oscillator, Component Location

3. Set gage factor dial at 2.0.

4. Turn instrument power on.

5. Bring Indicator meter to a null as in paragraph 4.2 a 1 to 4.

6. Capacity Balance the indicator as in 4.1f.

7. Offset the counter, using the Balancing knob, by 75 microinches per inch. This will give the peak to peak input voltage of figure 10a.

8. All voltages given are peak to peak values.

9. The scope setting used are as follows:

   1. Sweeptime — 1ms/cm
   2. Vertical sensitivity — as indicated under each wave form of Figure 10.

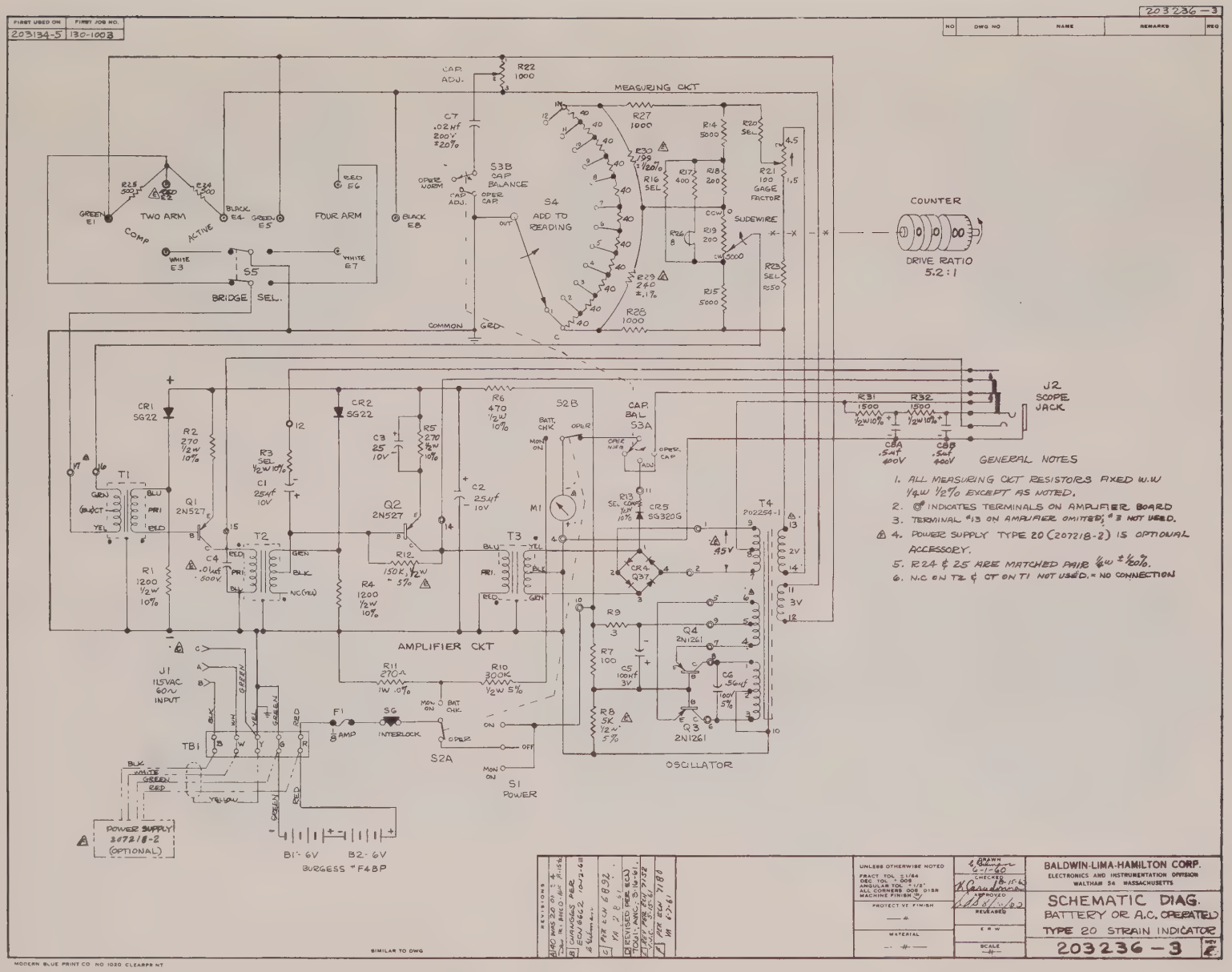
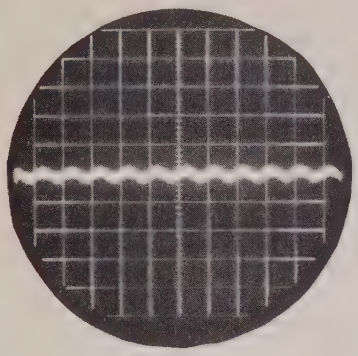
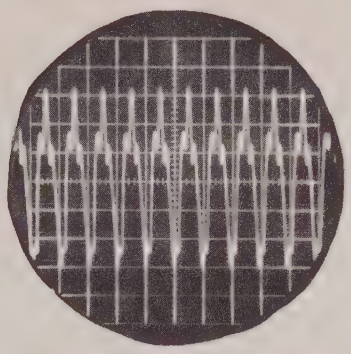


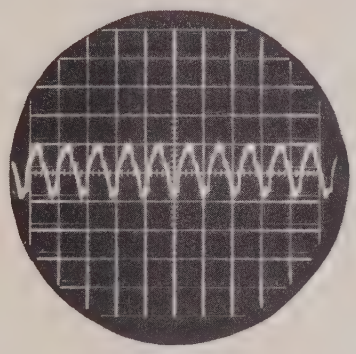
Figure 9. Schematic Diagram Type 20 Strain Indicator



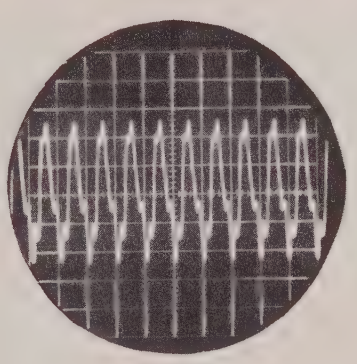
A. Signal input to amplifier, across primary of T1, — .4mv. Vert. sensitivity of scope — 1mv/cm.



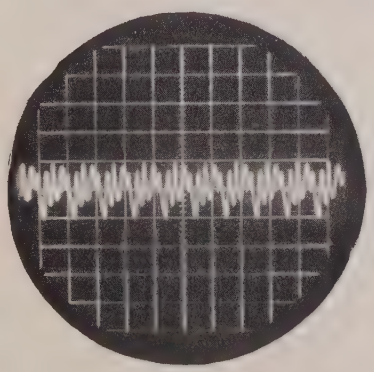
B. Output of 1st stage, across primary of T2, — 12.4 mv. Vertical sensitivity of scope — 2mv/cm.



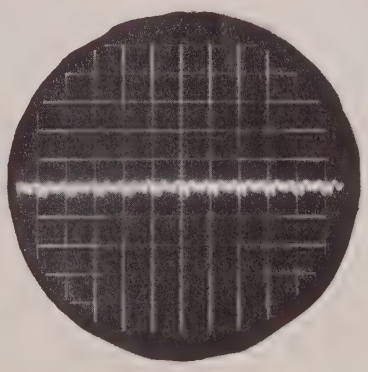
C. Input to second stage, across secondary of T2 (BLK & GRN) — 2mv. Vertical sensitivity of scope — 1mv/cm.



D. Output of second stage, across primary, T3 — 1V Vertical sensitivity of scope — .2 v/cm.



E. Typical output of amplifier at Null. Vertical sensitivity of scope — .2v/cm.



F. B_+ of battery powered unit — 10 volts. Vertical sensitivity of scope — .2v/cm.

Figure 10. Amplifier waveforms. (test data)

SECTION 8
SPECIFICATIONS

Strain Indicator (Type 20) Specifications

Input	1, 2 or 4 arm strain gage networks
Gage Resistance	60 to 2000 ohm gages.
Counter Range	5000 μin/in.
No. of Intervals	12 at 5000 μin/in each.
Total Indicator Range	$\pm$30,000 μin/in or 60,000 μin/in.
Readout	Digital.
Power Requirements	Two 6v batteries or 115v 60 cycle power pack.
Response speed	Manual Null balance.
Accuracy	$\pm$0.1% of reading or 5 μin/in.
Linearity	$\pm$0.1% of interval.
Sensitivity	Less than 2 μin/in.
Dynamic Range	$\pm$5000 μin/in $\cong$ $\pm$0.1V at a gage factor of 2, 0-50 cps at the scope jack.
Size	9 1/2"H x 12 29/32 W x 8 13/32 D
Weight	Approximately 18 lbs.

SECTION 9
PARTS LIST

NOTE

When ordering parts from the factory always include the following information:

Instrument Model No.

Serial No.

B-L-H Part No.

Description of Part.

Refer to figure for Circuit Ref.

CIRCUIT REF.	PART DESCRIPTION	B-L-H PART NO.	QUAN.
	AMPLIFIER, OSCILLATOR		
R1, R4	Resistor, fixed, comp.,1200 ohms ½w, ±10%	127219-8	2
R3	Resistor, fixed, comp,( ) ½w, ±10%		1
R2, R5	Resistor, fixed, comp.,270 ohms ½w, ±10%	127211-8	2
R6	Resistor, fixed, comp.,470 ohms ½w, ±10%	127214-8	1
R7	Thermistor 100 ohm	203207-1	1
R8	Resistor, fixed,comp,( ) ½w, ±10%		1
R9	Resistor, w.w., ½w, 3 ohms, ±5%	132689-8	1
R10	Resistor, fixed, comp.,300K, ½w, ±5%	129912-8	1
R11	Resistor, comp., 1w. 270 ohms ±10%	127288-8	1
R12	Resistor, fixed,comp.,½w ( ) ±10%		1
R13	Resistor, fixed,comp.,( ) ½w ±10%		1
Q1, Q2	Transistor	GE 2N527	2
Q3, Q4	Transistor	Minn. Honeywell 2N1261	2
CR1, 2	Stabistor, Bias Diode	Transitron SG22	2
CR4	Germanium Diode, Quad	Bradley CX23E4A882	1
CR5	Stabistor	Transitron SG320G	1
C1-C3	Capacitor, 25MFD, 10VDC	Aerovox #PTT42	3
C4	Capacitor, Mica, ( ) 500V	ELEMCO CM-30	1
C5	Capacitor, 100 MFD, 3VDC	133540-8	1
C6	Capacitor, paper, .56 MFD, 100V	133538-8	1
T1-T3	Transformer	203198-1	3
T4	Transformer, Distribution	202254-1	1
	MEASURING & POWER CIRCUIT		
R14, R15	Resistor, Prec. w.w.,5K, ¼w, ±½%	130379-8	2
R16	Resistor, Prec. w.w., ( ) ¼w, ±½%		1
R17	Resistor, Prec. w.w., 400 ohms, ¼w ±½%	130352-8	1
R18	Resistor, Prec. w.w., 200 ohms, ¼w ±½%	130345-8	1
R19	Potentiometer, 200 ohms	101878-1	1
R20	Resistor, Prec. w.w., ( ) ¼w, ±½%		1
R21	Potentiometer, 100 ohms	204277-1	1
R22	Potentiometer, Series 43C, 1K	SK3979-16	1
R23	Resistor, Prec. w.w., ( ) ¼w, ½%		1
R24, R25	Resistors, Prec. w.w., 500 ohms, 1/20%	204863-1	1
R26	Trimmer, 8 ohms	101724-1	1
R27, R28	Resistor, Prec. w.w., 1K, ¼w, ±½%	130362-8	2
R29	Resistor, Prec. w.w., 239 ohms ±1/10%	133562-8	1

( ) denotes values selected at the Calibration of the Instrument.

CIRCUIT REF.	PART DESCRIPTION	B-L-H PART NO.	QUAN.
R30	Resistor, Prec. w.w., 300 ohms ±1/20%	133070-8	1
R31, R32	Resistor,Carbon comp.,1500 ohms ½w ±%	127220-8	2
C7	Capacitor, paper, .02 MFD, 200V	131282-8	
C8	Capacitor, oil, dual, .5 MFD, 400V	132504-8	1
S1	Switch, Toggle, (Power)	133532-8	1
S2	Switch, Toggle, (Oper-Batt.Chk.)	133531-8	1
S3	Switch, (Cap. Bal.)	104436-1	1
S4	Switch, Rotary (Add to Reading)	202343-1	1
S5	Switch, Toggle, DPDT, (Bridge Sel)	133559-8	1
S6	Switch, Push Button (Interlock)	205958-1	1
J1	Connector	Amphenol 97-3102A-10S1-3P	1
J2	Jack, scope	204824-1	1
B1, B2	6V Batteries	Burgess F4BP	2
TB1	Terminal Strip	Cinch Jones 5-140Y	1
F1	Fuse, ⅛A, 250V	128584-8	1
M1	Meter	202346-1	1
	AC POWER PACK		
T101	Transformer	Triad F-25X	1
CR101	Selenium Rectifier	G.E. GRS 21GBIAADI	1
C101, C102	Capacitor-Electrolytic, 250 MFD, 25V	C.D. BR2502	2
C103	Capacitor-paper, .5MFD, 200V	Aerovox Type P922N	1
R101	Resistor, fixed, W.W., IRC BW ½, 15 ohms ±5%	132706-8	1
R102	Resistor, fixed, W.W., IRC BW 1, 47 ohms ±5%	132797-8	1
	MISCELLANEOUS		
	Knob (ADD TO READING)	124852-8	1
	Knob (CAP. BAL.)	124850-8	1
	Knob (CAP. ADJ.)	124814-8	1
	Dial-Turn, counting (Gage Factor)	203301-1	1
	Knob (Balancing)	203135-1	1
E4, E8	Binding Post	133519-8	2
E3, E7	Binding Post	133517-8	2
E1, E5	Binding Post	133520-8	2
E6, E2	Binding Post	133518-8	2
	Fuse Holder	131050-8	1
	Index Window	202782-1	1
	Counter	202785-1	1

INSTRUMENT
CENTER

BLH